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# EXPLORATION AND DEVELOPMENT OF MIDDLE SIZED UNDERGROUND MINES

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## Exploration and development of middle sized under ground mines

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An ore body can be defined as a deposit of metal mineral which can be economically worked, beneficiated and realised. The world's ore reserves are therefore not entirely dependant upon the deposit's grade and the mineral concentrate's selling price, but upon the capital which must be invested in prospecting, exploration, development, mining and mineral dressing.

Large deposits with low grades can often be exploited, thanks to the low mining costs that occur with large enterprises whereas small ore bodies, such as the Scandinavian sulphide deposits, have higher costs per ton and therefore demand higher metal grades.

However, relatively small and low grade deposits can be mined, especially if one company is responsible for the exploitation of several such units.

The Boliden Mining Company is working 15 ore deposits of which the majority have an annual production of less than 200.000 tons. The deposit which last came into production, and those which are now being explored, are in the size range 1-3 million tons.

The ores which have been found by the company's prospecting department are not considered part of the ore reserves

before their size and grade have been determined through comprehensive drifting and diamond drilling. This exploration, which is conducted to increase the ore reserves, is a part of long term planning to maintain a suitable supply to the mineral dressing plants.

The characteristics of the Scandinavian sulphide deposits - thin steeply dipping lenticular or tabular bodies, sometimes deep - require very comprehensive exploration before it can be definitely said wether or not they are workable. With this the most costly work is the sinking of an exploratory shaft 300-400 meters deep.

A special method has been developed for doing this type of exploration of which an account will be given here. The aim has been to shorten the time required for this underground exploration and to invest as little capital as possible in the plant in case the investigations should give a negative result.

Since company long term mining policies may mean deferring actual exploitation of proven ore for as long as twenty years, it is naturally advantageous that capital should not be tied up in surface plant during this time. In addition, the plant would probably become obsolete before mining is resumed. Consequently for exploratory underground work the surface plant comprises lightweight portable units.

It can also happen that the deposit may prove too small to justify the expense of a permanent plant. In this case, the entire ore body could be extracted using the small portable plant.

Should the exploration programme indicate that the deposit is not economic or if extraction of the ore is not commenced immediately, the entire surface plant can be moved to its next destination. Only some small concrete foundations remain as a monument to unfulfilled hopes.

Two such installations are now in operation and are briefly described. As a large part of the plant is embodied in the form of carriages, reminiscent of a circus environment, the name "mine circus" is applied to the installations.

The head frame, of which there are two types depending upon whether one or two head sheaves are used, is a 30-meter-high tripod, with legs constructed of prefabricated sections. These are made of prefabricated tubular lattice girders of a maximum length of seven meters. It has a total weight of 15,3 tons and is designed for a pay load of 16 tons. After the tree concrete foundations are poured, erection takes only a few days.

The 365-h.p. hoists is of eight tons capacity and has a rope speed of four meters per second. The ultimate hoisting depth is 625 meters which is sufficient for normal requirements. The hoists is bolted down on a concrete slab. The motor-generator set and contact breaker unit is mounted on a carriage, located in the hoist room. The pre-fabricated sides and roof of this building are of galvanized corrugated sheeting.

The switchboard and 10000/380 volt transformer are installed in a carriage having a wheel base of 6,9 meters and a width of 2,3 meters. The transformer of 800 kVA capacity operates at a frequency of 50 c/s. The switchboard is divided into high-tension and low-tension compartments.

Compressed air is supplied by three compressors, also mounted on carriages. There are three identical carriages with a 3,5 meter wheel base and a width of 1,8 meters. Installed on each is a compressor with a capacity of 10,6 cubic meters per minute at a delivery pressure of eight atmospheres.

Aerial Cableway

When a full bucket is hoisted to the top of the headframe

a dumping door automatically falls out over the shaft. The rock is emptied into a bin and passes via a shaking feeder to a measuring bin of 1,9 tons capacity. This bin discharges into a 1,1 ton bucket of an aerial tramline.

The aerial cableway has a 42 mm diameter track cable, one end of which is attached below the headframe and the other is anchored on the far side of a 19-ton 60-meter high pylon of pipe construction. The pylon is guyed with two side stay lines. It is built of 10 meter long prefabricated sections.

The aerial dumping bucket has two wheels running on the cable and is moved by a 17-mm diameter pull and return rope operated by an automatic hoist. The hoist is placed on the far side of the pylon whilst the control equipment is beside that for the shaft hoist in the operator's cabin. The 80-h.p. hoist has a rope speed of 3,4 meters per second. Capacity of the tramway when the rock pile is 170 meters from the shaft is 40 tons per hour.

The bucket is bottom-opening, the trap door being opened by a tripping device suspended from the track cable. When it becomes necessary to move the dumping point the tripper is shifted to the desired position by a 5 mm-diameter wire rope and a hand winch. Between the shaft and the pylon, a distance of 220 meters, there is sufficient capacity for about 200.000 tons of broken material.

Other Prefabricated Carriages

The two hoist houses, shaft house and water pump house are constructed of light sections which are easily fitted together. The rest of the buildings come as prefabricated carriages.

The carriages are built of watertight plywood on a bolted framework, the outer wall being covered with "Boliden"

impregnated panels. They have the following dimensions: length 9,8 meters, width 2,4 meters; and height 3,3 meters. For transport, these carriages are put on simple trailers and at the site they are placed on four timber sleepers thus raising them 30 cm off the ground. The air heating system comprises a fan behind each carriage in a row of five, which draws warm air through a pipe from an oil-fired boiler. The hoistman's carriage has a separate boiler.

The work shop carriage is furnished with all the standard equipment needed for the repair and maintenance of drills. It also serves as a store for spare parts.

Amenities in the refreshment carriage include refrigerator, oven, stove, three tables with four chairs per table and at the far end a 2,5 by 2,0-meter rest platform, on which the workers can lie down during their break.

There are two identical changing room carriages with washroom each having accommodation for twelve men. The carriage contains a drying stand for waterproof attire, a boot scrubber and drying rack, twelve ventilated lockers for ordinary clothes, a stand for mine clothes, a washroom with a 300-litre immersion heater, and two showers.

The mine captain's office, with work tables and cupboards, is situated in a carriage together with two small stores and a small changing room containing a bench, a shower and five lockers.

The hoistman sits in the end section of a carriage with the control and signal equipment for both hoist and aerial cableway. The rest of this carriage is subdivided into a shiftboss's office and a lamproom for 30 lamps where the time clock is also housed.

Other Installations

A large shed beside the shaft contains equipment continually

needed in the shaft, such as pipes, pumps, concreting frames, sets, and drills. This building also contains sharpening facilities for drill steels, a 5-ton overhead crane, storage space for electrical and other equipment and a rescue depot.

Sand and gravel are stored in a heated bin. From a 250-litre mixer, concrete is introduced directly to a 0,6 cu. meter skip through a pipe.

The shaft sinking method devised by Boliden is such that a sinking rate of about 40 meters a month can be attained at reasonable cost, which is considered satisfactory. This rate is exclusive of cutting stations but includes placing concrete rings , bolting wire mesh to the shaft wall, and installing shaft services. On this basis, the aim is to complete the sinking project at as low a cost and with as small a crew as possible. Sinking is carried out on three shifts in such a way that a 2,4 meter round is drilled and blasted in the first shift and mucking and other work is performed in the remaining two shifts.

As a rule shafts are sunk to a depth of 400-450 meters at a diameter of 4,6 meters. Drifts are driven at 50-meter intervals from which diamond drilling is immediately carried out to ascertain the grade and extent of the ore. If results are disappointing, shaft sinking is discontinued until the problem can be more carefully studied and a decision made either to proceed or to abandon the project.

To mechanize drilling in this undertaking, a circular drill rig is used which enables one man to operate two machines for a certain portion of the drilling. Mucking is done with a Cryderman shaft mucker.

At present the labour force comprises three men per shift

in the shaft, a hoistman, a shiftboss and on the day shift a fitter who looks after the machines, sharpens drill steel, etc. The three workers at the shaft bottom achieve a sinking rate of about 20 cm per manshift inclusive of construction work and bolting wire mesh to the walls.

Shaft sinking is a specialized job which requires experienced personnel, and therefore to avoid the necessity of training men at the various mines, there is within the company a special shaft sinking department. At the present this department is responsible for three sinking operations, one in Kristineberg, one in Udden and one in Långdal and expectations are that crews will be fully occupied for many years ahead.

Fig. 1 A general view of the shaft sinking plant at Näsliden, where a 440 meter shaft was recently sunk by Boliden. From left to right - five portable carriages, shaft house, headframe and dumping arrangement, hoistroom, two compressor carriages and water pump house.

Fig. 2 Another view of the plant at Näsliden showing the dumping arrangement and the cable for the aerial tramway.

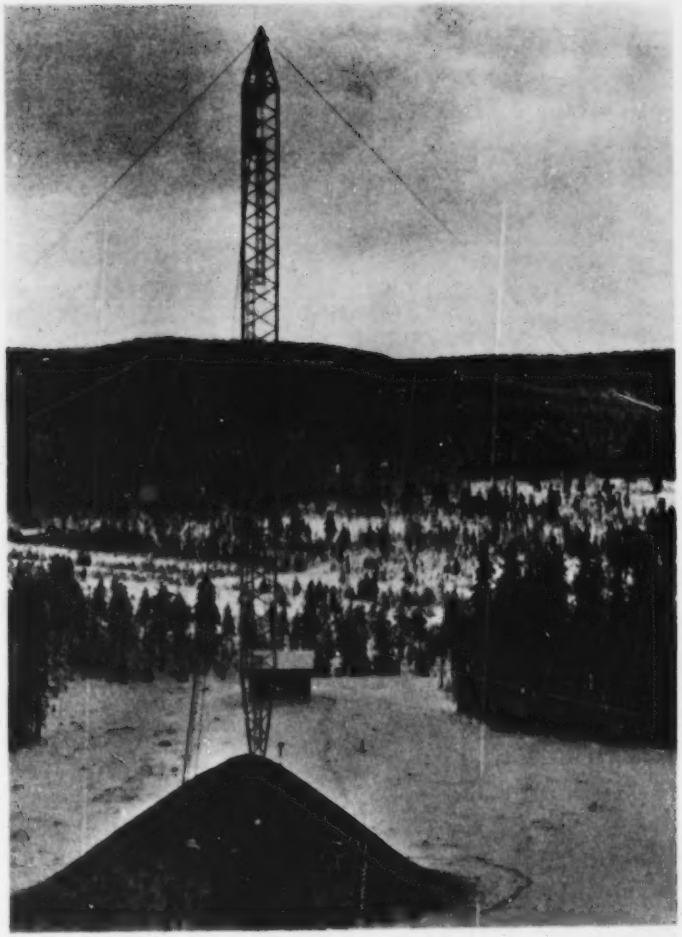

Fig. 3 The pylon for the aerial tramway is constructed of prefabricated sections. The dumping bucket runs on a cable and is moved by a pull and return rope. The hoist house for this can be seen behind the pylon.

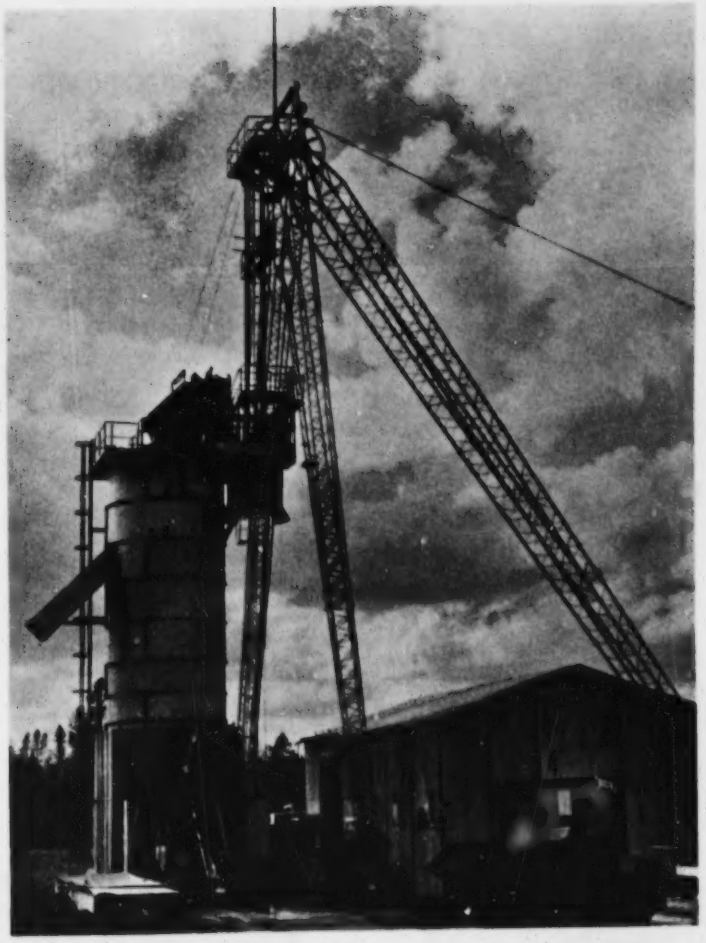

Fig. 4 At the shaft sinking plant at Udden the bucket is emptied into a bin. The waste rock is taken away by truck and used for building a road to another deposit.

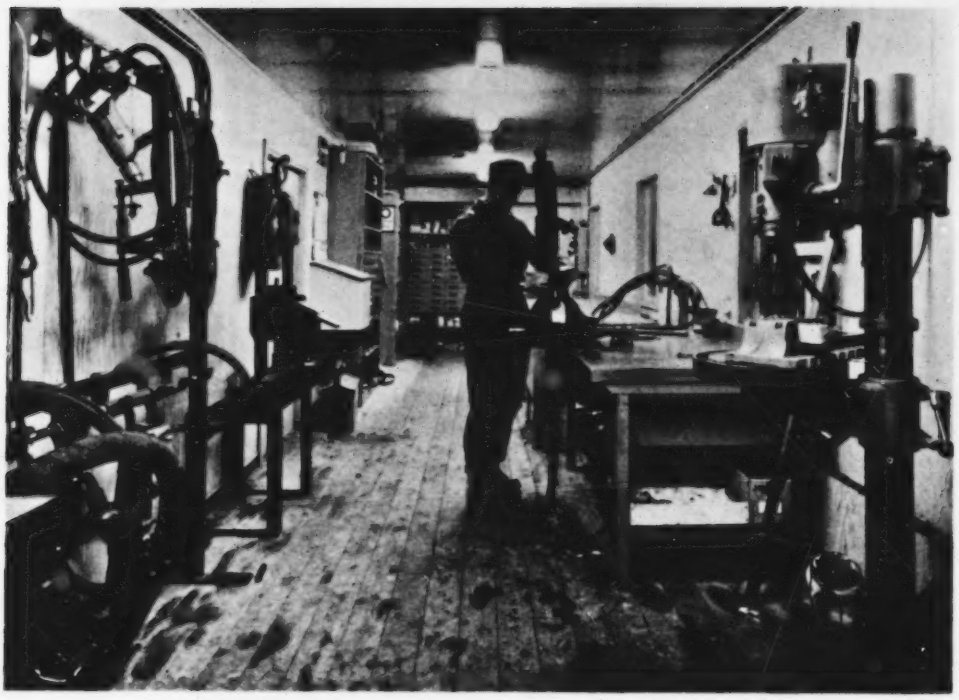

Fig. 5 The workshop, which houses standard equipment for the repair of drills, contains also a small store for spare parts.

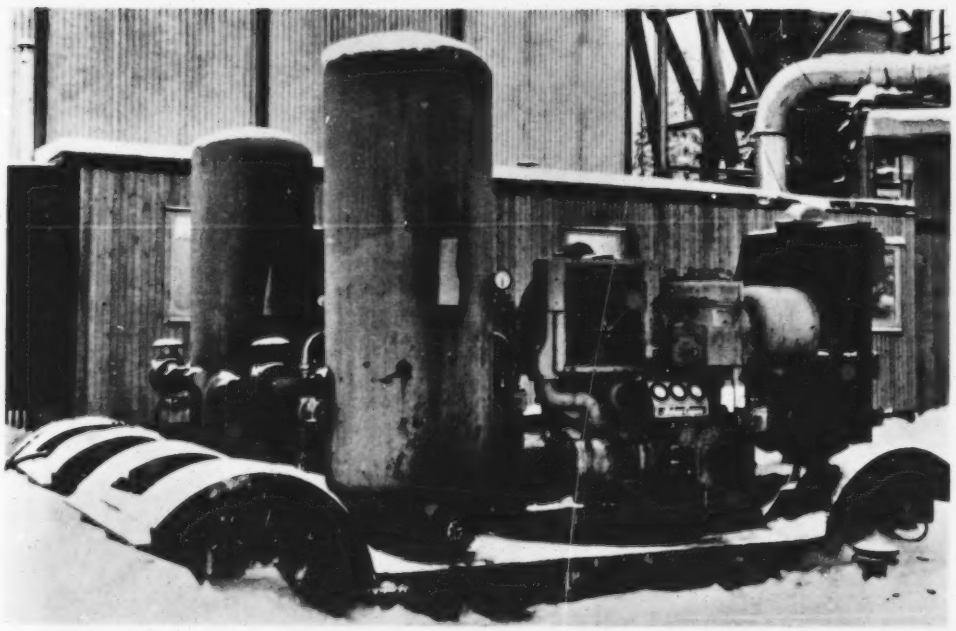

Fig. 6 Two of the aircooled compressors on their carriages. At the site the wheel axles are removed and the carriages placed on timber sleepers.



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